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ANDERSON ENGINEERING INC SPRINGFIELD MO

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NATIONAL DAM SAFETY PROGRAM, LAKE KAH-TAN-DA DAM (MO 30838), MI--ETC(U)

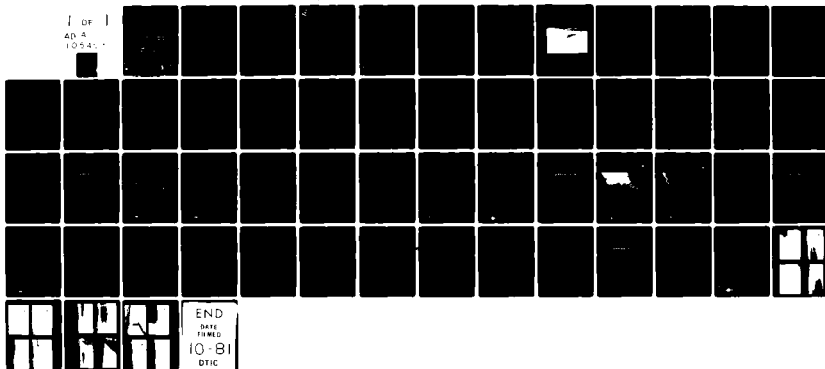
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MISSISSIPPI-KASKASKIA-ST. LOUIS RIVER BASIN

LAKE KAH-TAN-DA DAM
PERRY COUNTY, MISSOURI
MO 30838

PHASE 1 INSPECTION REPORT NATIONAL DAM SAFETY PROGRAM



United States Army
Corps of Engineers
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St. Louis District

PREPARED BY: U.S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

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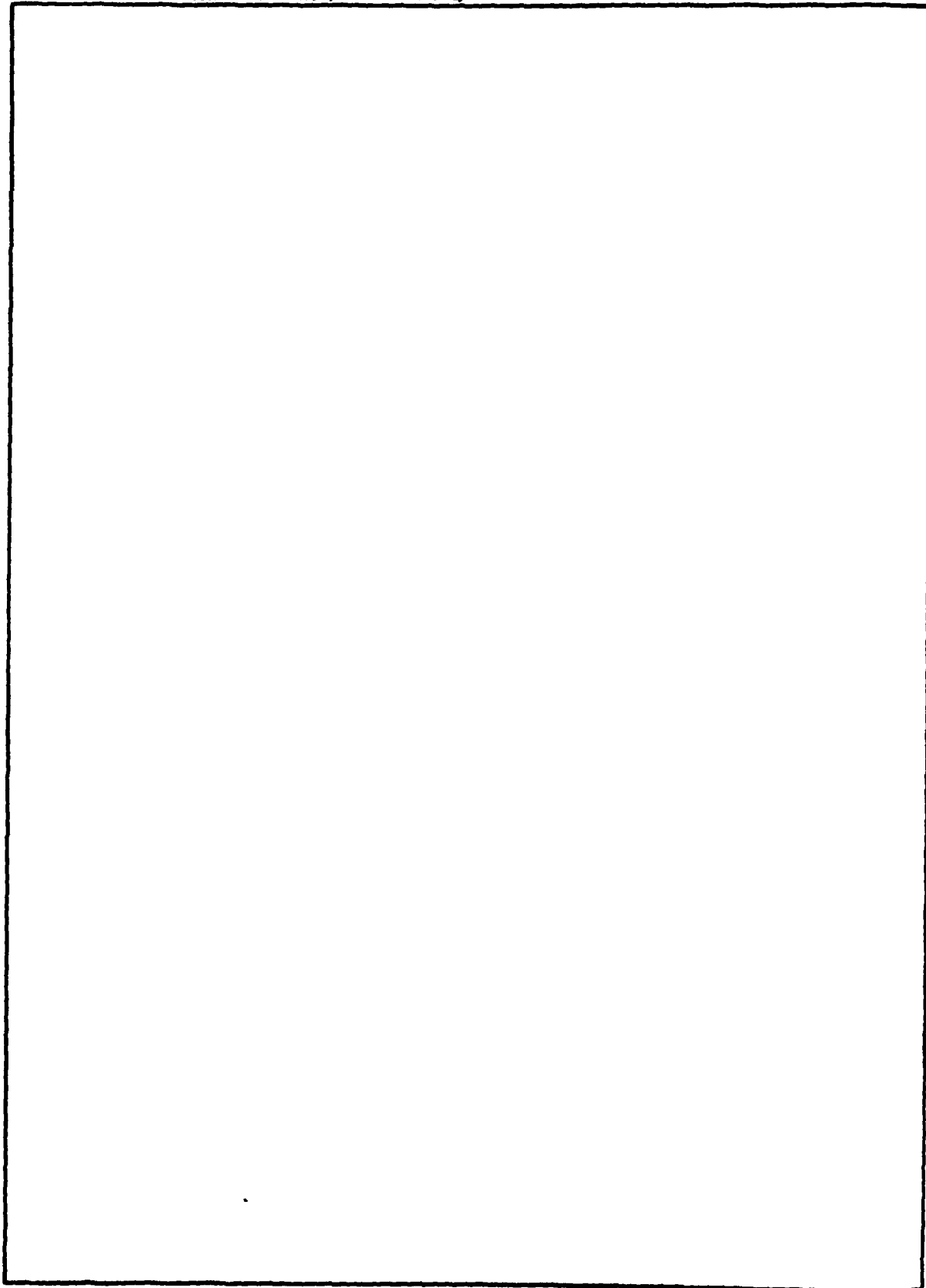
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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

SUBJECT: Lake Kah-Tan-Da Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Lake Kah-Tan-Da Dam (MO No. 30838)

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

- a. Spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.
- b. Overtopping of the dam could result in failure of the dam.
- c. Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY:

SIGNED

Chief, Engineering Division

SIGNED

APPROVED BY:

Colonel, CE, Commanding

16 JUL 1981

Date

17 JUL 1981

Date

Recommendation For	
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MISSISSIPPI-KASKASKIA-ST. LOUIS RIVER BASIN

LAKE KAH-TAN-DA DAM

PERRY COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30838

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared By

Anderson Engineering, Inc., Springfield, Missouri
Hanson Engineers, Inc., Springfield, Illinois

Under Direction Of

St. Louis District, Corps of Engineers

For

Governor of Missouri

APRIL 1981

PHASE 1 REPORT
NATIONAL DAM SAFETY PROGRAM
SUMMARY

Name of Dam:	Lake Kah-Tan-Da Dam
State Located:	Missouri
County Located:	Perry
Stream:	Tributary of Nations Creek
Date of Inspection:	18 December 1980

Lake Kah-Tan-Da Dam was inspected by an interdisciplinary team of engineers from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

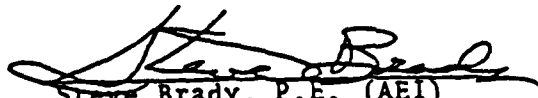
The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers, and they have been developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, the St. Louis District, Corps of Engineers has determined that this dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur if the dam fails. The estimated damage zone extends approximately 6 miles downstream of the dam. Located within this zone are five dwellings, a highway, and the town of Silver Lake. The existence of these downstream features was verified during the field inspection and at the time the aerial photographs were taken. The dam is in the intermediate size classification, since it is greater than 40 ft high but less than 100 ft high.

Our inspection and evaluation indicates that the spillways do not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The spillway will pass 30 percent of the Probable Maximum Flood without overtopping. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The guidelines require that a dam of intermediate size with a high downstream hazard potential pass 100 percent of the PMF. The 1 percent probability flood will not overtop the dam. The 1 percent probability flood is one that has a 1 percent chance of being exceeded in any given year.

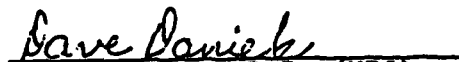
Deficiencies visually observed by the inspection team were: (1)

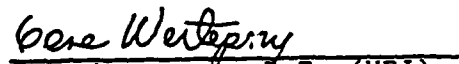
lack of wave protection on the upstream face; (2) wave erosion with a few shallow sloughs along the upstream face; (3) erosion gullies all along the downstream face; (4) fairly deep erosion gully at the left downstream dam-abutment contact; and (5) wet areas (possible seepage) at the left downstream contact and in the valley near the downstream toe of the dam. Another deficiency was the lack of seepage and stability analysis records.

It is recommended that the owners take the necessary action promptly to correct the deficiencies reported herein. A detailed discussion of these deficiencies is included in the following report.


Steve Brady, P.E. (AEI)


Tom Beckley, P.E. (AEI)


Dave Daniels, P.E. (HEI)


Gene Wertepny, P.E. (HEI)



AERIAL VIEW OF LAKE AND DAM

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SECTION 1 - PROJECT INFORMATION

1.1 GENERAL:

A. Authority:

The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection be made of Lake Kah-Tan-Da Dam in Perry County, Missouri.

B. Purpose of Inspection:

The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and a visual inspection in order to determine if the dam poses hazards to human life or property.

C. Evaluation Criteria:

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, "Recommended Guidelines for Safety Inspection of Dams, Appendix D." These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT:

A. Description of Dam and Appurtenances:

Lake Kah-Tan-Da Dam is an earth structure approximately 56 ft high and 850 ft long at the crest. In this report, right and left orientation is based on looking in the downstream direction. The appurtenant works consist of a rock cut spillway in the right abutment.

B. Location:

The dam is located in the southwest part of Perry County, Missouri on a tributary of Nations Creek. The dam and lake are within the Perryville West, Missouri 7.5 minute quadrangle sheet (Section 13, T34N, R9E-latitude 37 deg. 38.9 min. , longitude 89 deg. 59.5 min.). Sheet 2 of Appendix A shows the general vicinity.

C. Size Classification:

With an embankment height of 56 ft and a maximum storage capacity of approximately 907 acre-ft, the dam is in the intermediate size category.

D. Hazard Classification:

The St. Louis District, Corps of Engineers has determined that this dam is in the high hazard potential classification. The estimated damage zone extends approximately 6 miles downstream of the dam. Located within this zone are five dwellings, a highway, and the town of Silver Lake. The existence of these downstream features was verified during the field inspection and at the time the aerial photographs were taken.

E. Ownership:

The dam is owned by Norbert Giesler. The owner's address is Star Rte Box 228A, St. Mary's, Missouri 63673 (telephone: 314-543-2972).

F. Purpose of Dam:

The dam was constructed primarily for recreation.

G. Design and Construction History:

The dam was constructed in 1966 by Giesler Brothers Construction Company of Perryville, Missouri. Design advice was provided by a Mr. James Bennett of Fredricktown, Missouri and a Mr. Al Hoskins of Cape Girardeau, Missouri. The owner indicated that the materials for the dam were taken mainly from the lake area, and that some material was taken from an area downstream of the dam. He said that the dam was constructed with bulldozers and rubber tired scrapers and that the most clayey materials were placed in the center 20 ft section of the embankment. He indicated that a 12 ft deep and 12 ft wide cutoff trench was incorporated beneath the dam. The base of the cutoff was taken to smooth rock or to hard clay. The owner said that a clay and bentonite mixture was placed in the cutoff trench, and that the only modification was an extension of the berm on the left side of the spillway in 1968.

H. Normal Operating Procedures:

Normal flows are discharged through the rock cut spillway. The

owner reported that the highest water level occurred in 1968 after a 5 in. rain when the level was about 2 ft above the crest of the spillway. He indicated that the spillway normally operates all summer long with at least a small discharge over the spillway, and that the dam has never been overtopped.

1.3 PERTINENT DATA:

Pertinent data about the dam, appurtenant works, and reservoir are presented in the following paragraphs. Sheet 3 of Appendix A presents a plan, profile, and typical section of the embankment.

A. Drainage Area:

The drainage area for this dam, as obtained from the USGS quad sheet, is approximately 494 acres.

B. Discharge at Dam Site:

- (1) All discharge at the dam site is through an uncontrolled spillway.
- (2) Estimated Total Spillway Capacity at Maximum Pool (Top of Dam - El. 674.6 (low point)): 544 cfs
- (3) Estimated Capacity of Primary Spillway: 544 cfs
- (4) Estimated Experienced Maximum Flood at Dam Site: 148 cfs
- (5) Diversion Tunnel Low Pool Outlet at Pool Elevation: Not Applicable
- (6) Diversion Tunnel Outlet at Pool Elevation: Not Applicable
- (7) Gated Spillway Capacity at Pool Elevation: Not Applicable
- (8) Gated Spillway Capacity at Maximum Pool Elevation: Not Applicable

C. Elevations:

All elevations are consistent with an assumed mean sea level elevation of 670.0 for the crest of the spillway (estimated from quadrangle map).

- (1) Top of Dam: 674.6 (low point)

- (2) Principal Spillway Crest: 670.0
- (3) Emergency Spillway Crest: Not Applicable
- (4) Principal Outlet Pipe Invert: Not Applicable
- (5) Streambed at Centerline of Dam: 619.5
- (6) Pool on Date of Inspection: 669.6
- (7) Apparent High Water Mark: Not Evident on the day of the inspection
- (8) Maximum Tailwater: Unknown
- (9) Upstream Portal Invert Diversion Tunnel: Not Applicable
- (10) Downstream Portal Invert Diversion Tunnel: Not Applicable

D. Reservoir Lengths:

- (1) At Top of Dam: 3,100 ft
- (2) At Principal Spillway Crest: 2,900 ft
- (3) At Emergency Spillway Crest: Not Applicable

E. Storage Capacities:

- (1) At Principal Spillway Crest: 700 acre-ft
- (2) At Top of Dam: 907 acre-ft
- (3) At Emergency Spillway Crest: Not Applicable

F. Reservoir Surface Areas:

- (1) At Principal Spillway Crest: 42 acres
- (2) At Top of Dam: 48 acres
- (3) At Emergency Spillway Crest: Not Applicable

G. Dam:

- (1) Type: Earth

- (2) Length at Crest: 850 ft
- (3) Height: 56 ft
- (4) Top Width: 19 ft
- (5) Side Slopes: Upstream 3H:1V and 7.8H:1V, Downstream 2.5H:1V and 2.6H:1V
- (6) Zoning: Center Clay Core (From Owner)
- (7) Impervious Core: 20 ft wide (From Owner)
- (8) Cutoff: 12 ft wide, 12 ft deep (From Owner)
- (9) Grout Curtain: None

H. Diversion and Regulating Tunnel:

- (1) Type: Not Applicable
- (2) Length: Not Applicable
- (3) Closure: Not Applicable
- (4) Access: Not Applicable
- (5) Regulating Facilities: Not Applicable

I. Spillway:

I.1 Principal Spillway:

- (1) Location: Right Abutment
- (2) Type: Rock Cut

I.2 Emergency Spillway:

- (1) Location: None
- (2) Type: None

J. Regulating Outlets:

There are no regulating outlets.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN:

No engineering data were available, nor were documentation of construction inspection records or documented maintenance data.

A. Surveys:

No information regarding pre-construction surveys was obtained. Sheet 3 of Appendix A presents a plan, profile and cross section of the dam from survey data obtained during the site inspection. The top of the southwest wing wall of the spillway bridge structure was used as a reference point to determine all other elevations. It is estimated that this site datum approximately corresponds to mean sea level (MSL) elevation 676.1 (estimated from quad sheet).

B. Geology and Subsurface Materials:

The site is located in the east-central portion of the Ozarks geologic region of Missouri. The Ozarks are characterized topographically by hills, plateaus, and deep valeys. The most common bedrock types are dolomite, sandstone, and chert. The "Geologic Map of Missouri" indicates that the bedrock in the site area consists of the Smithville, Powell, Cotter, and Jefferson City formations. These formations consist of predominantly cherty dolomites. Caves and springs are common in these formations. The publication "Caves of Missouri" lists a total of four caves known to exist in Perry County. These caves are clustered in a 12 sq mile area about 10 miles east of the site.

The "Geologic Map of Missouri" indicates several normal faults southwest and northwest of the site about 5 miles away. It should also be noted that the site is located in seismic zone 2 (moderate damage zone) but is near the boundary of zone 3 (major damage zone - see Sheet 3 of Appendix B).

The soils are of the Memphis-Loring Soil Associations and have developed from loess deposited over weathered material from cherty dolomites. The loessial thickness map indicates that upland areas may have between 5.0 and 10.0 ft of loess cover. Auger probes in the dam indicated a brown clayey silt (ML-CL).

C. Foundation and Embankment Design:

No foundation or embankment design information was available. Seepage and stability analyses required by the guidelines were not available. Information from the owner regarding source of materials and foundation and embankment construction is contained in Section 1.2G.

D. Hydrology and Hydraulics:

No hydrologic or hydraulic design computations were available. Based on a field check of spillway dimensions and embankment elevations, a check of the drainage area on the USGS quad sheet, hydrologic analyses using U.S. Army Corps of Engineers guidelines were performed and appear in Appendix C.

E. Structures:

No design information on the spillway bridge structure was available.

2.2 CONSTRUCTION:

No construction inspection records were available.

2.3 OPERATION:

Normal flows are passed by an uncontrolled rock cut spillway. There are no other operating facilities.

2.4 EVALUATION:

A. Availability:

No engineering data, seepage or stability analyses, or construction test data were available.

B. Adequacy:

The engineering data available were inadequate to make a detailed assessment of the design, construction, and operation of this structure. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

C. Validity:

To our knowledge, no valid engineering data on the design or construction of the embankment are available.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS:

A. General:

The field inspection was made on 18 December 1980. The inspection team consisted of personnel from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The team members were:

Steve Brady - Anderson Engineering, Inc. (Civil Engineer)
Tom Beckley - Anderson Engineering, Inc. (Civil Engineer)
Gene Wertepny - Hanson Engineers, Inc. (Hydraulic Engineer)
Dave Daniels - Hanson Engineers, Inc. (Geotechnical Engineer)

The owner was not on the site during inspection. Photographs of the dam, appurtenant structures, reservoir, and downstream features are presented in Appendix D.

B. Dam:

The dam appears to be generally in good condition. The upstream slope is grass covered and clear of trees and brush. There is no wave protection, and wave erosion was noted all along the upstream slope with the existence of a few shallow sloughs (see Photo 3). There were no animal holes noted.

The crest of the dam is clear with a gravel roadway (see Photo 4). The crest appeared fairly uniform horizontally and vertically, and no cracking or unusual movement was observed.

The downstream slope is grass covered and clear of trees and brush (see Photo 5). No sloughs, animal holes or seepage were noted. Erosion gullies 6 in. to 1.5 ft deep were noted all along the downstream face at a distance of 3 ft to 5 ft apart. There is a fairly deep erosion gully (as much as 3 ft deep) at the left downstream dam-abutment contact (see Photo 6). An area of marsh vegetation and standing water was also noted in this area (see Sheet 5 of Appendix A and Photo 7). Several wet areas were also noted in the valley within 20 ft to 100 ft of the downstream toe of the dam (see Photo 8). No measurable flows were noted in any of these areas.

C. Appurtenant Structures:

C.1 Principal Spillway:

The spillway for the dam consists of a rock cut in the right abutment. There is a 1 ft wide concrete control section across the crest of the spillway. The approach and discharge areas are fairly clear, and flows are directed away from the dam by an earth berm on the left side of the spillway.

A bridge over the spillway is supported by a concrete abutment on the left side and a concrete footing on rock on the right side. The bridge deck consists of a concrete surface on corrugated metal sheets, which is in turn supported on steel I-beams. The bridge appears to be in good condition (see Photos 8 through 13).

C.2 Emergency Spillway:

There is no emergency spillway. There are also no draindown facilities. An attempt was made to draw down the lake for shoreline repairs last year with a siphon system. The system consisted of four 4 1/2 in. plastic pipes embedded about 1 ft below the crest of the dam. Flexible plastic corrugated pipes were attached to the intake and discharge ends. The attempts to draw down the lake failed when the flexible discharge pipes failed under the pressure (see Photo 14). The owner indicated that this system has since been removed (after the inspection visit).

D. Reservoir:

The watershed is primarily wooded with some subdivision development around the shoreline. The slopes adjacent to the dam are moderate, and no significant sloughing was noted. No significant sedimentation was observed.

E. Downstream Channel:

The downstream channel is poorly defined in the immediate area of the dam and heavily wooded.

3.2 EVALUATION:

The eroded condition of the upstream face will worsen if wave protection is not provided. The erosion gullies on the downstream face and at the left contact should be repaired. The wet marshy areas should be monitored to detect any increase in flows or transportation of soil particles with the water.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES:

There are no operating facilities for this dam. The pool is normally controlled by rainfall, runoff, evaporation, seepage, and the capacity of the uncontrolled spillway.

4.2 MAINTENANCE OF DAM:

The embankment was clear of trees and brush on the day of the inspection, so that maintenance in this regard is apparently done on a regular basis.

4.3 MAINTENANCE OF OPERATING FACILITIES:

There are no operating facilities.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT:

The inspection team is unaware of any existing warning system for this dam.

4.5 EVALUATION:

The lack of riprap on the upstream face and the eroded areas on the dam are deficiencies which could become serious if not corrected. A regular program of maintenance of eroded areas should be established.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES:

A. Design Data:

No hydrologic or hydraulic design computations for this dam were available.

B. Experience Data:

No recorded rainfall, runoff, discharge, or reservoir stage data were available for this lake and watershed. The owner indicated that the maximum depth of water over the spillway was about 2 ft in 1968 after a 5 in. rain.

C. Visual Observations:

The approach and outlet areas for the spillway are clear. The bridge over the spillway is in good condition. The spillway outlet channel is well separated from the embankment by an earth berm so that spillway releases would not be expected to endanger the dam.

D. Overtopping Potential:

The hydraulic and hydrologic analyses (using the U.S. Army Corps of Engineers guidelines and the HEC-1 computer program) were based on: (1) a field survey of spillway dimensions and embankment elevation, and (2) an estimate of the reservoir storage and the pool and drainage areas from the Perryville West, Missouri, 7.5 minute USGS quad sheet.

Based on the hydrologic and hydraulic analysis presented in Appendix C, the spillway will pass 30 percent of the Probable Maximum Flood. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The recommended guidelines from the Department of the Army, Office of the Chief of Engineers, require that this structure (intermediate size with high downstream hazard potential) pass 100 percent of the PMF, without overtopping. The spillway will pass the 1 percent probability flood without overtopping the dam.

Application of the probable maximum precipitation (PMP), minus losses, resulted in a flood hydrograph peak inflow of 9,230 cfs.

The routing of the PMF through the spillway and dam indicates that the dam will be overtopped by 2.2 ft at elevation 676.8. The duration of the overtopping will be 6.4 hours, and the maximum outflow will be 7,830 cfs. The maximum discharge capacity of the spillway is 544 cfs. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY:

A. Visual Observations:

Observed features which could adversely affect the structural stability of this dam are discussed in Sections 3.1.B and 3.2.

B. Design and Construction Data:

Seepage and stability analyses comparable to the requirements of the guidelines were not available, which constitutes a deficiency which should be rectified.

C. Operating Records:

No operating records have been obtained.

D. Post-Construction Changes:

The only modification to the dam was an extension of the berm on the left side of the spillway in 1968.

E. Seismic Stability:

The structure is located in seismic zone 2. It is recommended that the prescribed seismic loading for this zone be applied in stability analyses performed for this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT:

This Phase I inspection and evaluation should not be considered as being comprehensive since the scope of work contracted for is far less detailed than would be required for an in-depth evaluation of dams. Latent deficiencies, which might be detected by a totally comprehensive investigation, could exist.

A. Safety:

The embankment is generally in good condition. Several items were noted during the visual inspection which should be investigated further, corrected, or controlled. These items are: (1) lack of wave protection on the upstream face; (2) wave erosion with a few shallow sloughs along the upstream face; (3) erosion gullies all along the downstream face; (4) fairly deep erosion gully at the left downstream dam-abutment contact; and (5) wet areas (possible seepage) at the left downstream contact and in the valley near the downstream toe of the dam.

Another deficiency was the lack of seepage and stability analyses records.

The dam will be overtopped by flows in excess of 30 percent of the Probable Maximum Flood. Overtopping of an earthen embankment could cause serious erosion and could possibly lead to failure of the structure.

B. Adequacy of Information:

The conclusions in this report were based on the performance history as related by others, and visual observation of external conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

C. Urgency:

If the deficiencies listed in paragraph 7.1.A are not corrected, and if good maintenance is not provided, the embankment condition will

continue to deteriorate and possibly could become serious in the future. The items recommended in paragraph 7.2 should be pursued promptly.

D. Necessity for Additional Inspection:

Based on the result of the Phase I inspection, no additional inspection is recommended.

E. Seismic Stability:

The structure is located in seismic zone 2. It is recommended that the prescribed seismic loading for this zone be applied in any stability analyses performed for this dam.

7.2 REMEDIAL MEASURES:

The following remedial measures and maintenance procedures are recommended. All remedial measures should be performed under the guidance of a professional engineer experienced in the design and construction of dams.

A. Alternatives:

- (1) Spillway size and/or height of dam should be increased to pass the PMF. In either case, the spillway should be protected to prevent erosion.

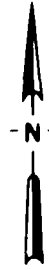
B. O and M Procedures:

- (1) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by an engineer experienced in the construction of dams.
- (2) The eroded and sloughed areas on the upstream face, and the eroded areas on the downstream face and at the left dam-abutment contact should be repaired and maintained.
- (3) Wave protection should be provided for the upstream face.
- (4) The wet and marshy areas should be monitored to detect any increase in flows and the transporting of soil particles with seepage water.

- (5) A detailed inspection of the dam should be made periodically by an engineer experienced in the design and construction of dams.

APPENDIX A

Dam Location and Plans



KANSAS CITY

ST. LOUIS

Location
of Dam

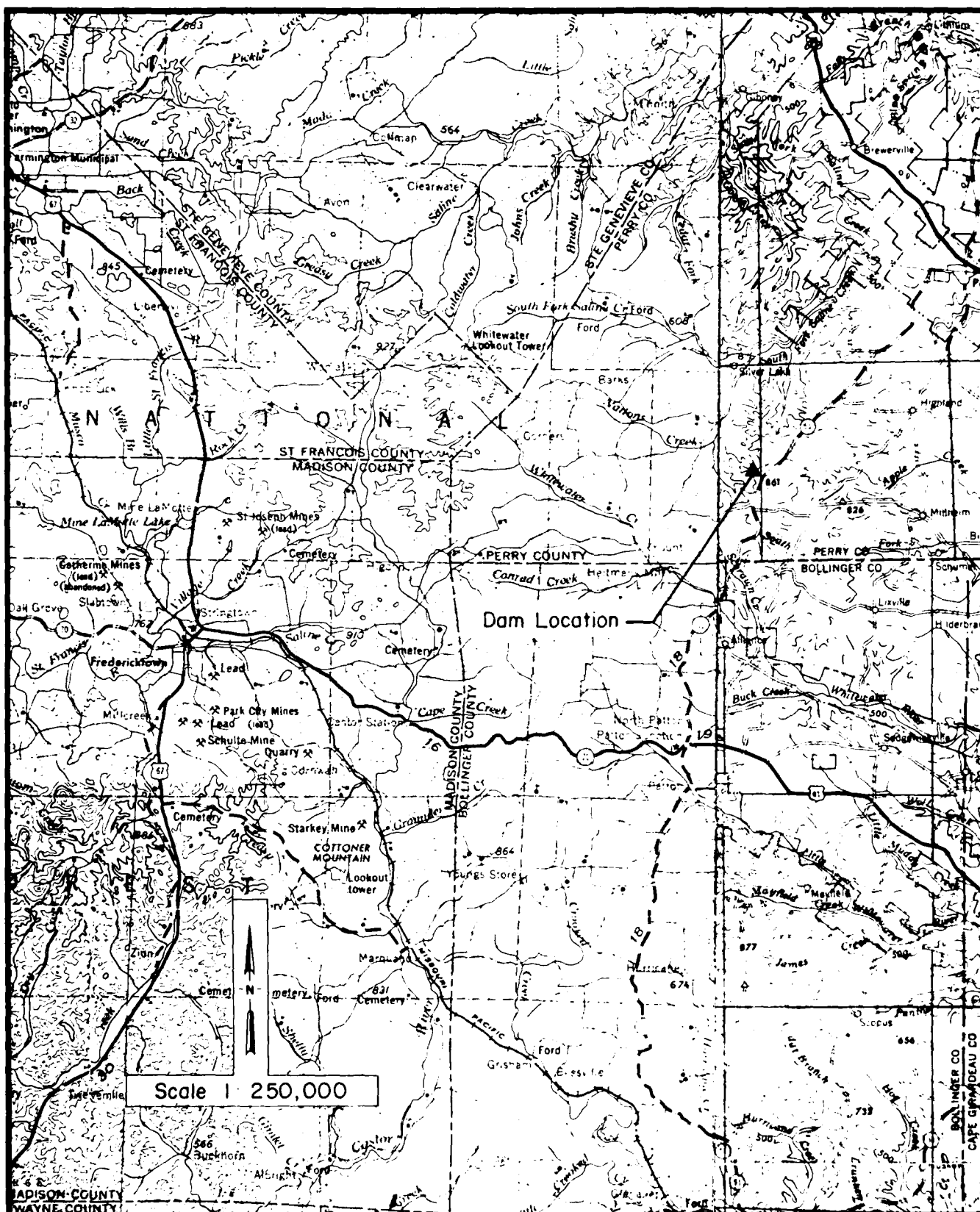
LOCATION MAP



SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Lake Kah-Tan-Da Dam
Perry County, Missouri
Mo. I.D. No. 30838

SHEET 1, APPENDIX A



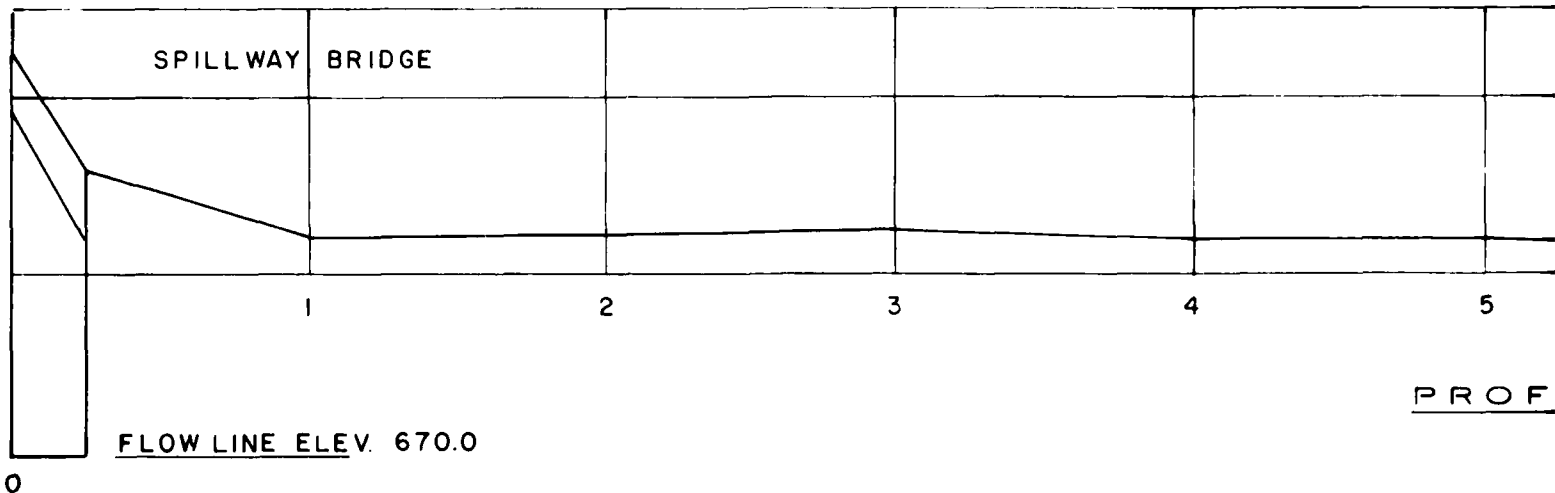
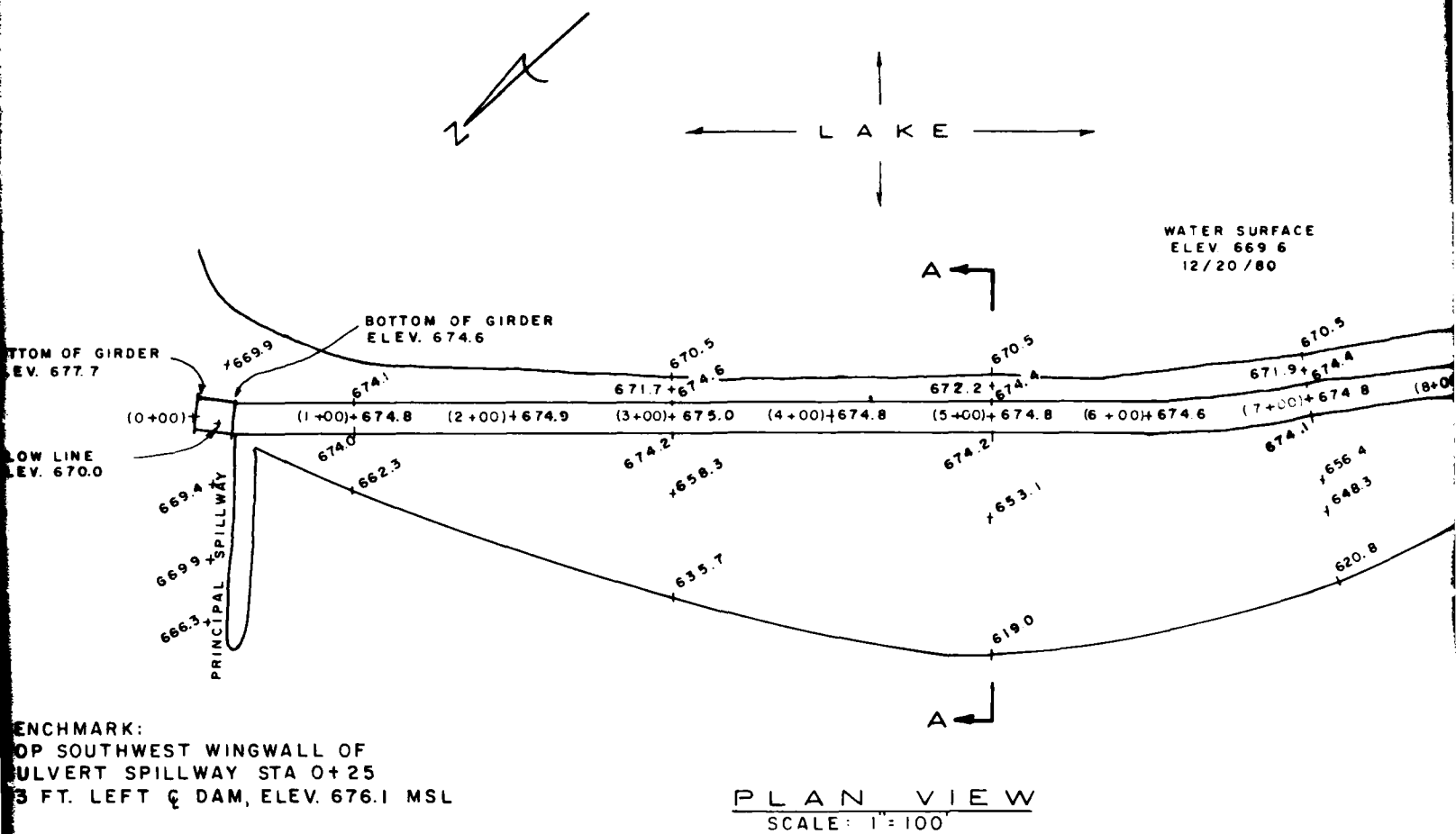
VICINITY MAP

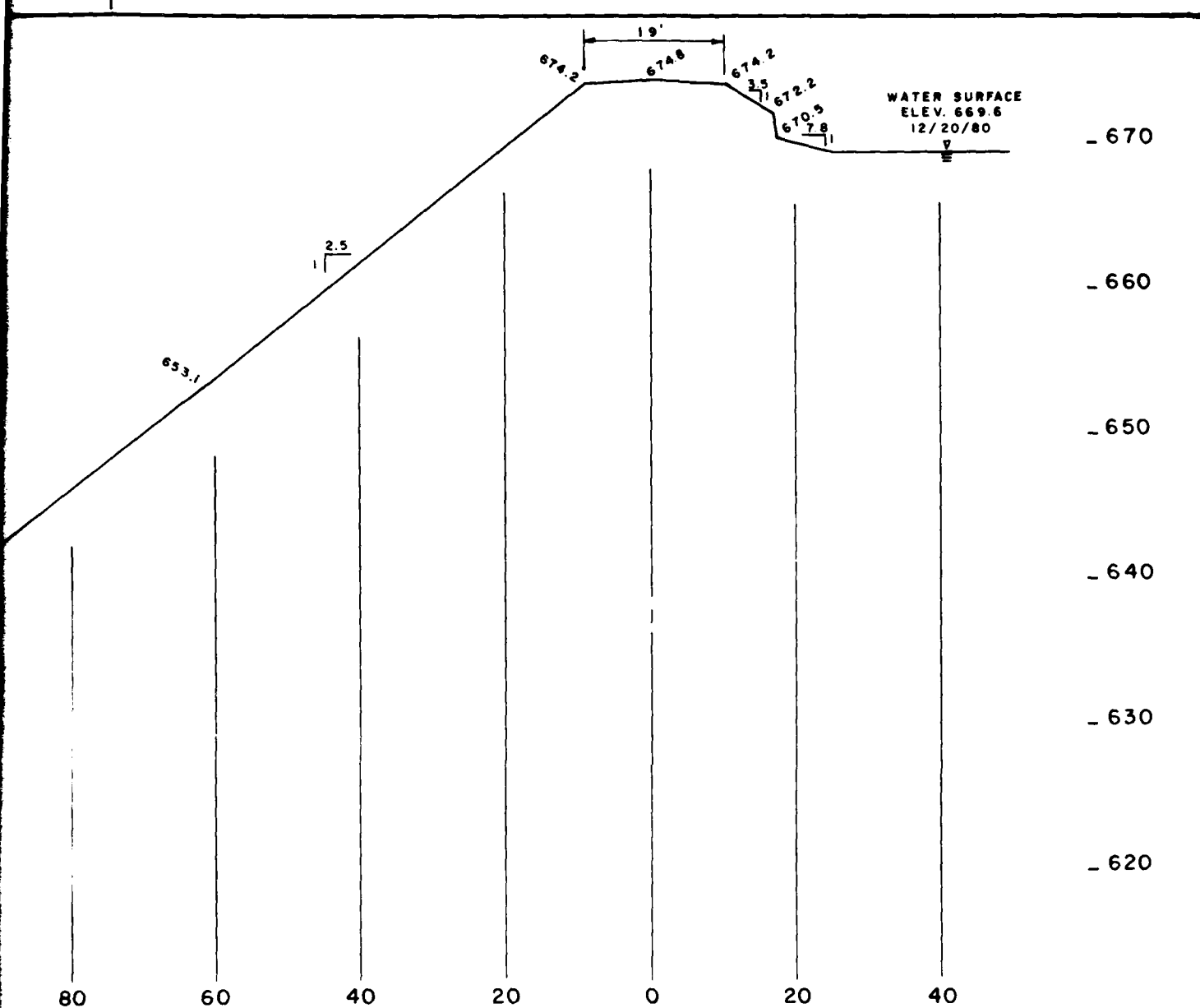


SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

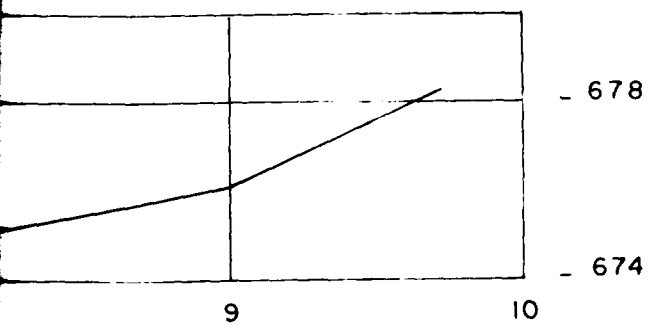
Lake Kah-Tan-Da Dam
Perry County, Missouri
Mo. I.D. No. 30838

Sheet 2, Appendix A



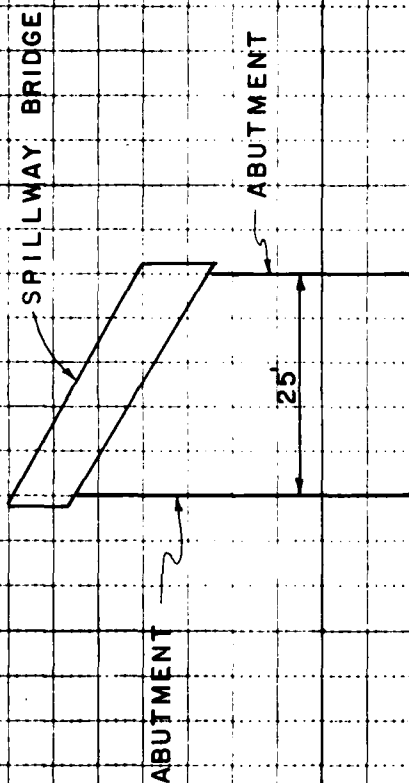


SECTION A - A STA 5+00

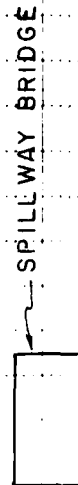


A/E	ANDERSON ENGINEERING, INC.
	730 N. BENTON AVE. • SPRINGFIELD, MO. 65802
LAKE KAH-TAN-DA DAM	
MO. No. 30838	
<u>PLAN & PROFILE</u> PERRY COUNTY, MO.	
SHEET 3 - APPENDIX A	

113



SPILLWAY SECTION AT Q DAM



Q DAM

UPSTREAM

DOWNSTREAM

WATER SURFACE
ELEV. 559.5
12/20/80

670

678

678

674

670

674

666

80

60

40

20

0

20

40

60

80

100

120

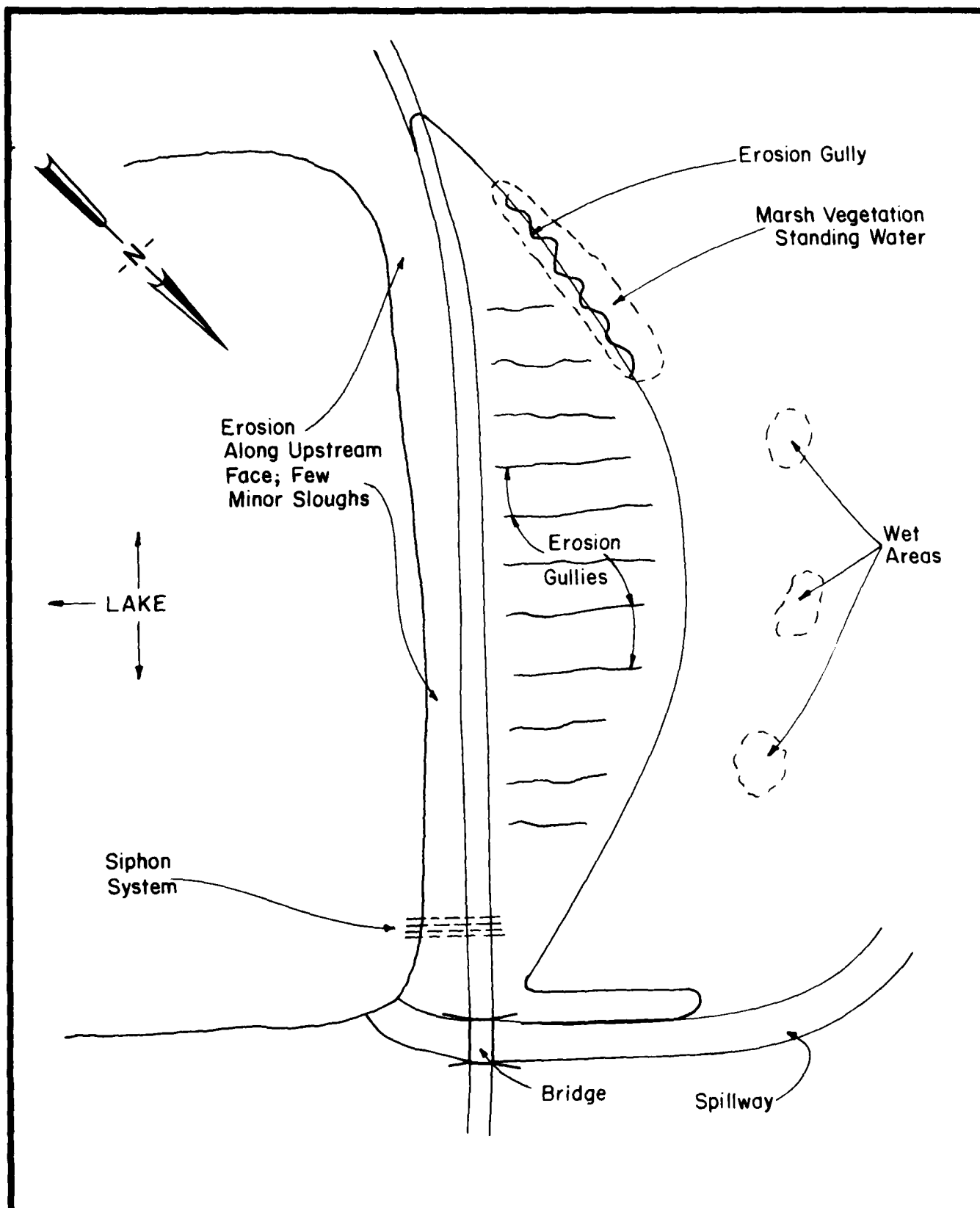
140

PROFILE - STA. 0+12 Q DAM

A/E ANDERSON
ENGINEERING, INC.
730 N. BENTON AVE. • SPRINGFIELD, MO. 65802

LAKE KAH-TAN-DA DAM
PERRY COUNTY, MISSOURI
MO. I.D. No. 30838
PRINCIPAL SPILLWAY
SECTION & PROFILE

SHEET 4, APPENDIX A



PLAN SKETCH OF FEATURES



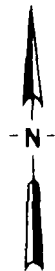
SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Lake Kah-Tan-Da Dam
Perry County, Missouri
Mo. I.D. No 30838

Sheet 5, Appendix A

APPENDIX B

Geology and Soils



LEGEND

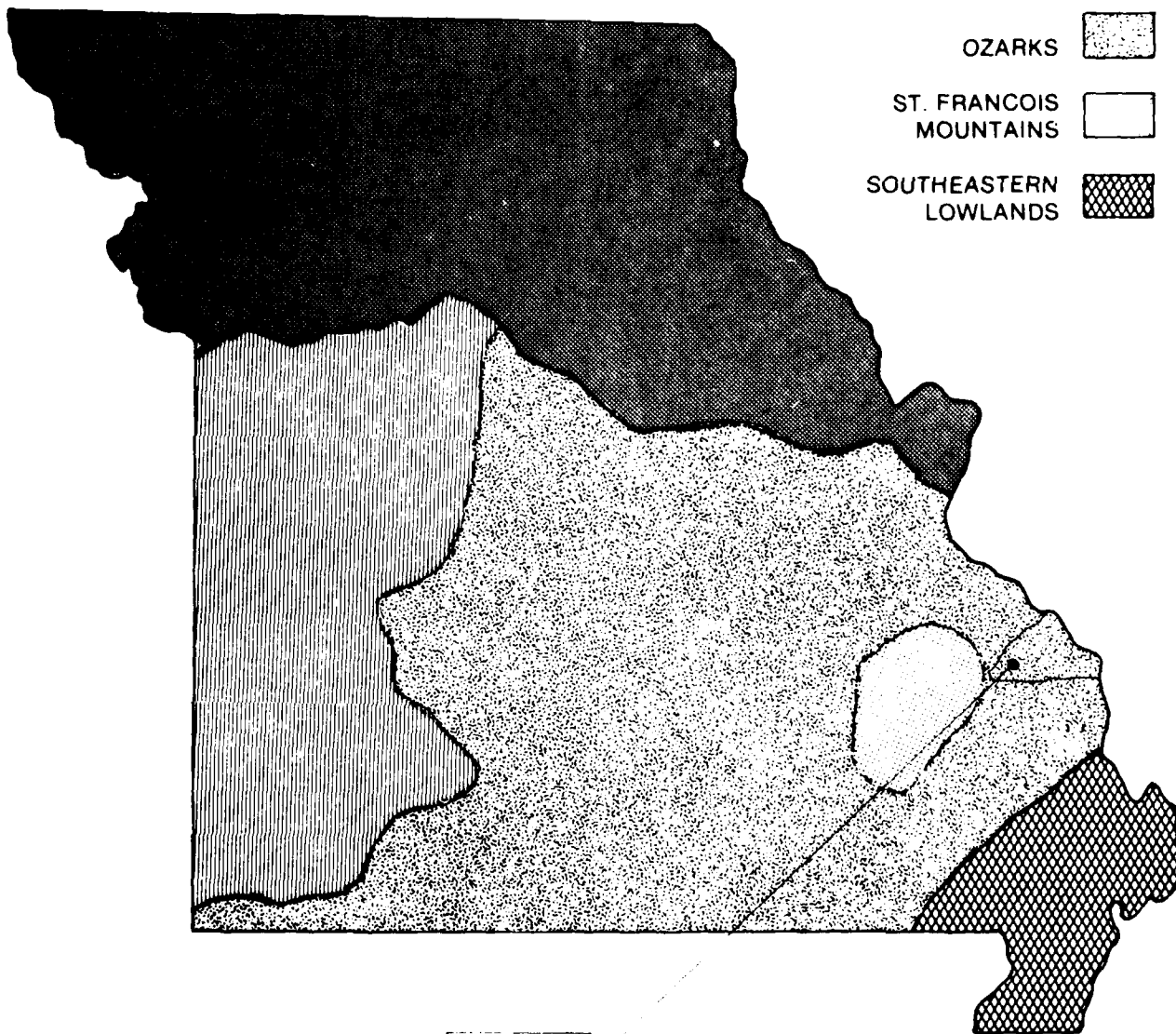
GLACIATED PLAINS 

WESTERN PLAINS 

OZARKS 

ST. FRANCOIS MOUNTAINS 

SOUTHEASTERN LOWLANDS 



Location
of Dam

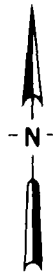
MAJOR GEOLOGIC REGIONS OF MISSOURI



SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Lake Kah-Tan-Da Dam
Perry County, Missouri
Mo I.D. No 30838

SHEET 1, APPENDIX B



FEET

20 +



10-20



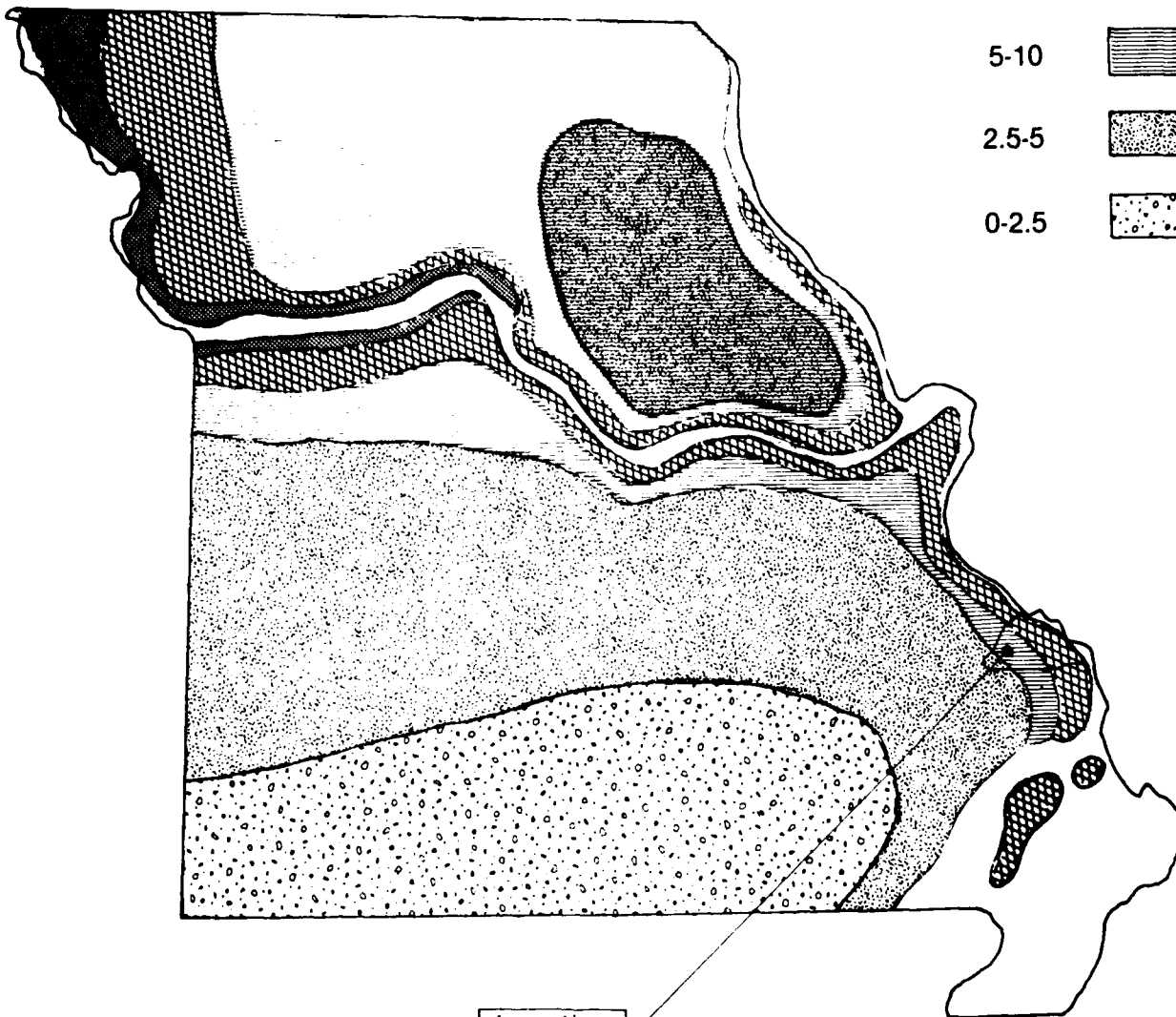
5-10



2.5-5



0-2.5



Location
of Dam

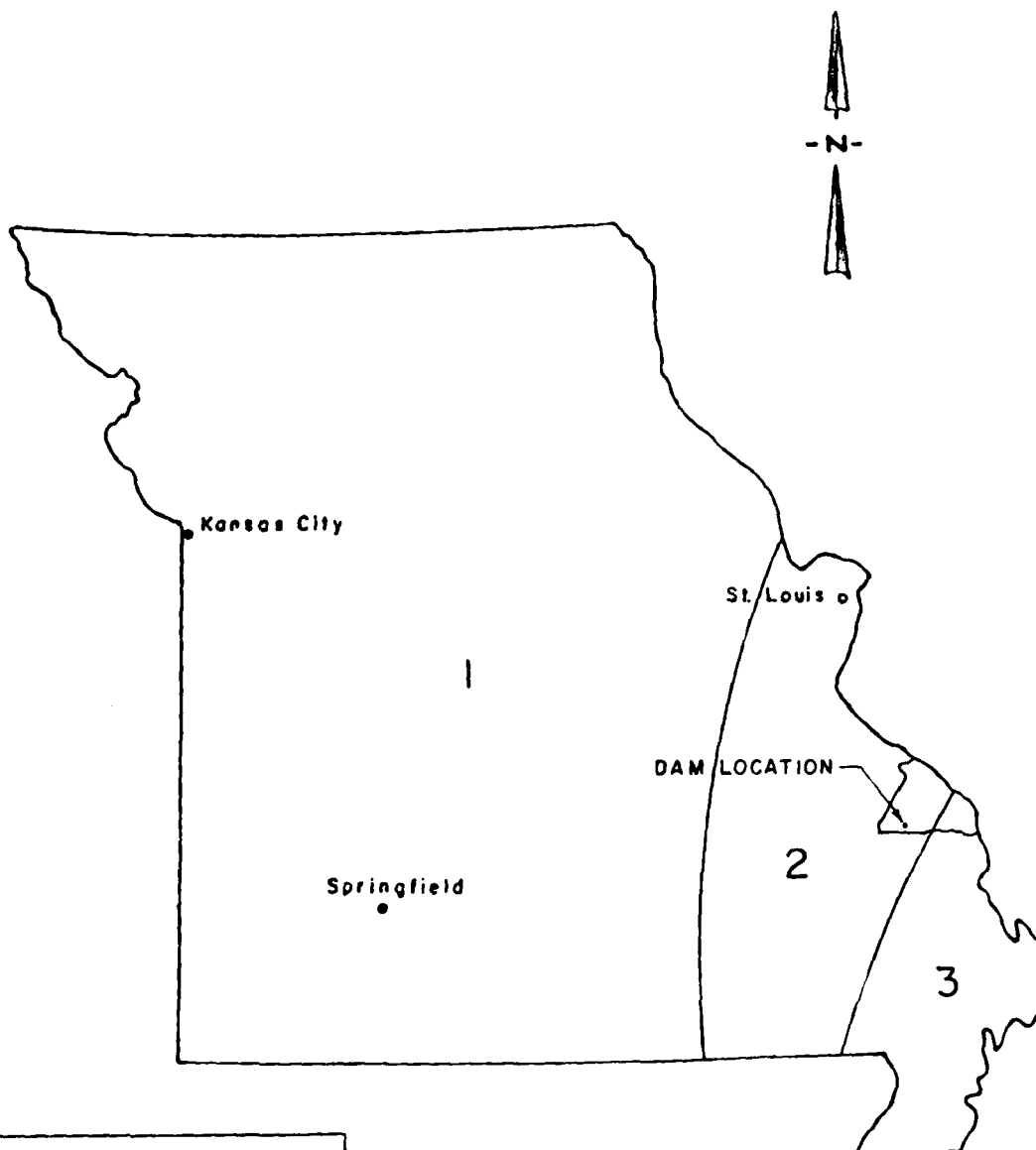
THICKNESS OF LOESSIAL DEPOSITS



SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Lake Kah-Tan-Da Dam
Perry County, Missouri
Mo I.D. No. 30838

SHEET 2, APPENDIX B



SEISMIC PROBABILITY	
ZONE	DAMAGE
1	MINOR
2	MODERATE
3	MAJOR

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ENGINEERING, INC.**
730 N. BENTON AVE. • SPRINGFIELD, MO. 65802

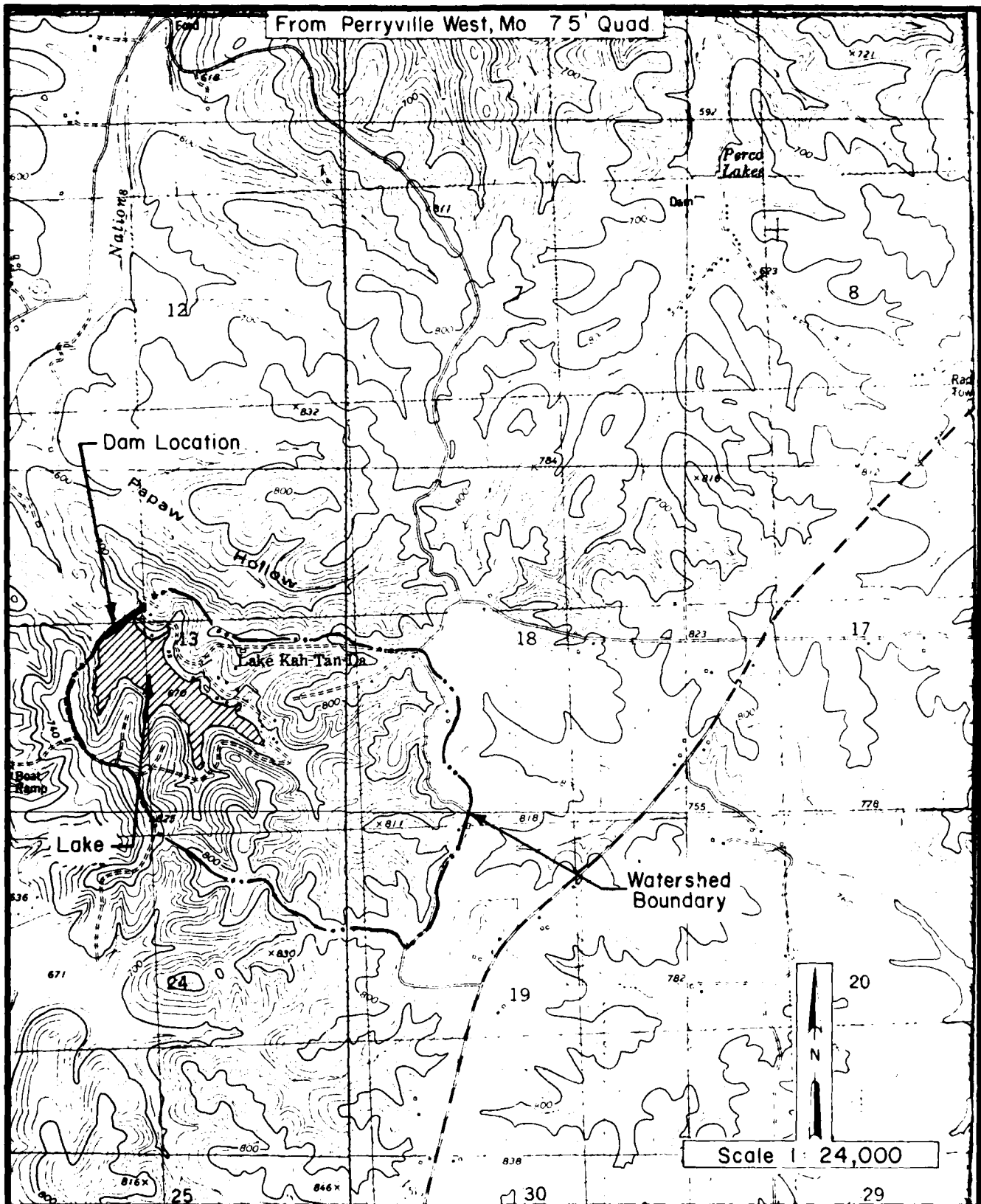
SEISMIC ZONE MAP

LAKE KAH-TAN-DA DAM
PERRY COUNTY, MISSOURI
MO. I. D. No. 30838

SHEET 3, APPENDIX B

APPENDIX C

Overtopping Analysis



LAKE AND WATERSHED MAP



SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Lake Kah-Tan-Da Dam
Perry County, Missouri
Mo. I.D. No. 30838

Sheet I, Appendix C

APPENDIX C

HYDROLOGIC AND HYDRAULIC ANALYSIS

To determine the overtopping potential, flood routings were performed by applying the Probable Maximum Precipitation (PMP) to a synthetic unit hydrograph to develop the inflow hydrograph. The inflow hydrograph was then routed through the reservoir and spillway. The overtopping analysis was accomplished using the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California.

The PMP was determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33." Reduction factors were not applied. The rainfall distribution for the 24-hour PMP storm duration was assumed according to the procedures outlined in EM 1110-2-1411 (SPD Determination). Also, the 1 percent chance probability flood was routed through the reservoir and spillway. St. Genevieve, Missouri rainfall distribution (5 min. interval - 24 hours duration), as provided by the St. Louis District, Corps of Engineers, was used in this case.

The synthetic unit hydrograph for the watershed was developed by the computer program using the SCS method. The time of concentration was estimated using the Kirpich formula. This formula and the parameters for the unit hydrograph are shown in Table 1 (Sheet 4, Appendix C). The time of concentration was also verified from velocity estimates for the average slopes of the watershed and the main channel (Design of Small Dams, page 70, 1974 Edition).

The SCS curve number (CN) method was used in computing the infiltration losses for rainfall-runoff relationship. The CN values used for the antecedent moisture conditions (AMC), and the result from the computer output, are shown in Table 2 (Sheet 5, Appendix C).

The reservoir routing was accomplished by using the Modified Puls Method assuming the starting lake elevation at normal pool. No antecedent storm was routed in order to determine the starting elevation. It was assumed that the mean annual high water elevation corresponds with the normal pool elevation. The hydraulic capacity of the spillway was used as an outlet control in the routing. The hydraulic capacity of the spillway and the storage capacity of the reservoir were defined by the elevation-surface area-storage-discharge relationships shown in Table 3 (Sheet 5, Appendix C).

The rating curve for the spillway (see Table 4 Sheet 6, Appendix C) was determined assuming flow through a box culvert with entrance control using charts from the U.S. Bureau of Public roads.

The flow over the crest of the dam during overtopping was determined using the non-level dam option (\$L and \$V cards) of the HEC-1 program. The program assumes critical flow over a broad-crested weir. The lowest elevation of the crest of the dam, obtained from survey measurements, was assumed as top of dam elevation.

A summary of the routing analysis for different ratios of the PMF is shown in Table 5 (Sheet 7, Appendix C). The result of the routings indicates that the spillway will pass the 1 percent probability flood without overtopping the dam.

The computer input data, a summary of the output data, and a plot of the inflow-outflow hydrograph for the PMF are presented on Sheets 8, 9, and 10 of Appendix C.

TABLE 1
SYNTHETIC UNIT HYDROGRAPH

Parameters:

Drainage Area (A)	0.77 sq miles
Length of Watercourse (L)	0.89 miles
Difference in elevation (H)	180 feet
Time of concentration (Tc)	0.31 hours
Lag Time (Lg)	0.19 hours
Time to peak (Tp)	0.23 hours
Peak Discharge (Qp)	1,625 cfs
Duration (D)	5 min.

<u>Time (Min.)(*)</u>	<u>Discharge (cfs)(*)</u>
0	0
5	419
10	1,347
15	1,588
20	1,187
25	626
30	356
35	198
40	110
45	61
50	34
55	19
60	12
65	5

(*) From the computer output

FORMULA USED:

$$T_c = \left(\frac{11.9 L^3}{H} \right)^{0.385}$$

Kirpich Formula.
From California Culverts Practice, California
Highways and Public Works, September, 1942.

$$L_g = 0.6 T_c$$

$$T_p = \frac{D}{2} + L_g$$

$$Q_p = \frac{484 A \cdot Q}{T_p} \quad Q = \text{Excess Runoff} = 1 \text{ inch}$$

TABLE 2
RAINFALL-RUNOFF VALUES

<u>Selected Storm Event</u>	<u>Storm Duration (Hours)</u>	<u>Rainfall (Inches)</u>	<u>Runoff (Inches)</u>	<u>Loss (Inches)</u>
PMP	24	34.3	32.9	1.4
1% Prob. Flood	24	7.1	4.5	2.6

Additional Data:

- 1) Soil Conservation Service Soil Group C
- 2) Soil Conservation Service Runoff Curve CN = 88 (AMC III) for the PMF
- 3) Soil Conservation Service Runoff Curve CN = 75 (AMC II) for the
1 percent probability flood
- 4) Percentage of Drainage Basin Impervious 10 percent

TABLE 3
ELEVATION, SURFACE AREA, STORAGE AND DISCHARGE RELATIONSHIPS

<u>Elevation (feet-MSL)</u>	<u>Lake Surface Area (acres)</u>	<u>Lake Storage (acre-ft)</u>	<u>Spillway Discharge (cfs)</u>
620.0	0	0	-
*670.0	42	700	0
**674.6	48	907	544
675.0	49	928	600
680.0	56	1,190	-

*Principal spillway crest elevation

**Top of dam elevation

The above relationships were developed using data from the USGS Perryville West, Missouri 7.5 minute quadrangle map and the field measurements.

TABLE 4

SPILLWAY RATING CURVE

<u>Reservoir Elevation</u> (MSL)	<u>Principal Spillway</u> (cfs)
670.0	0
671.0	60
672.0	148
673.0	310
674.0	460
*674.6	544
675.0	600
676.0	740
677.0	840
678.0	940

* Top of dam elevation

Method Used: Using chart from the U. S. Bureau of Public Roads for a box culvert with entrance control. Chart for outlet control was also used for checking.

TABLE 5
RESULTS OF FLOOD ROUTINGS

Ratio of PMF	Peak Inflow (cfs)	Peak Lake Elevation (ft, MSL)	Total Storage (acre-ft)	Peak Outflow (cfs)	Depth (ft) Over Top of Dam
-	0	*670.0	700	0	-
0.10	923	671.9	784	136	0
0.15	1,384	672.6	818	249	0
0.20	1,845	673.4	851	363	0
0.25	2,307	674.1	883	470	0
0.30	2,768	674.8	915	577	0.2
0.40	3,690	675.4	950	1,776	0.8
0.50	4,613	675.9	973	3,212	1.3
0.75	6,920	676.4	1,002	5,668	1.8
1.00	9,226	676.8	1,023	7,831	2.2

The percentage of the PMF that will reach the top of the dam is about 30 percent.

*Principal spillway crest elevation
Top of dam elevation = 674.6

A OVERTOPPING ANALYSIS FOR LAKE KAH-TAN-DA DAM (# 8)
 A STATE ID NO. 30838 COUNTY NAME : PERRY
 A HANSON ENGINEERS INC. DAM SAFETY INSPECTION JOB # 81S3001
 B 288 5
 B1 5
 J 1 9 1
 J1 .10 .15 .20 .25 .30 .40 .50 .75 1.0
 K 0 1
 K1 INFLOW HYDROGRAPH COMPUTATION **
 M 1 2 0.77 0.77 1
 P 0 26.4 102 120 130
 T -1 -88 0.10
 W2 0.31 0.19
 X 0 -.1 2
 K 1 2
 K1 RESERVOIR ROUTING BY MODIFIED PULS AT DAM SITE **
 Y 1 1
 Y1 1
 Y4 670.0 671.0 672.0 673.0 674.0 675.0 676.0 677.0 678.0
 Y5 0 60 148 310 460 600 740 840 940
 \$\$ 0 700 907 1190
 \$E 620.0 670.0 674.6 675.0 680.0
 \$\$ 670.0
 \$D 674.6
 \$L 0 200 400 700 710 780 850 900 920
 \$V 674.6 674.8 674.9 675.0 675.5 676.0 677.0 678.0
 K 99

PMF RATIOS
 INPUT DATA

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS															
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8	RATIO 9							
HYDROGRAPH AT	1	0.77	1	0.10	0.15	0.20	0.25	0.30	0.40	0.50	0.75	1.00							
	(1.99)	(26.13)	(39.19)	(52.25)	(65.31)	(78.38)	(104.50)	(130.63)	(195.94)	(
ROUTED TO	2	0.77	1	136.	249.	363.	470.	577.	1776.	3212.	5668.	7831.							
	(1.99)	(3.85)	(7.04)	(10.27)	(13.30)	(16.35)	(50.30)	(90.95)	(160.50)	(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1				INITIAL VALUE		SPILLWAY CREST		TOP OF DAM	
				ELEVATION		STORAGE		OUTFLOW	
				0.00		670.00		674.60	
				700.		700.		907.	
				0.		0.		544.	

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW		TIME OF FAILURE	
						HOURS		HOURS	
0.10	671.86	0.00	784.	136.	0.00	18.08	0.00	0.00	0.00
0.15	672.62	0.00	818.	249.	0.00	17.25	0.00	0.00	0.00
0.20	673.35	0.00	851.	363.	0.00	17.08	0.00	0.00	0.00
0.25	674.07	0.00	883.	470.	0.00	16.75	0.00	0.00	0.00
0.30	674.76	0.16	915.	577.	2.00	16.58	0.00	0.00	0.00
0.40	675.42	0.82	950.	1776.	3.00	16.00	0.00	0.00	0.00
0.50	675.85	1.25	973.	3212.	3.58	15.92	0.00	0.00	0.00
0.75	676.41	1.81	1002.	5668.	5.33	15.83	0.00	0.00	0.00
1.00	676.82	2.22	1023.	7831.	6.42	15.83	0.00	0.00	0.00

PMF RATIOS
 OUTPUT DATA

DISCHARGE (cfs)



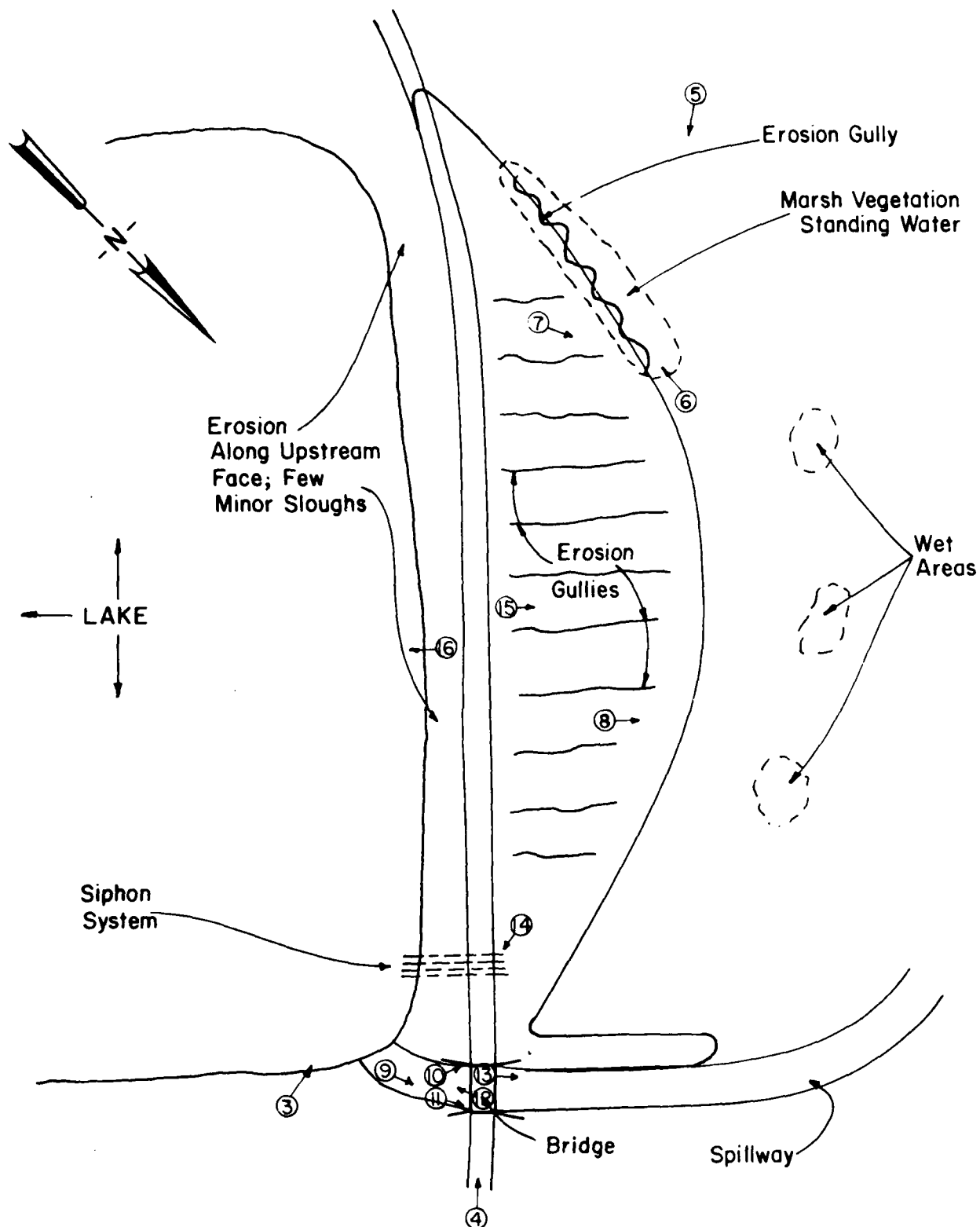
Sheet 10, Appendix C

APPENDIX D

Photographs

INDEX TO PHOTOGRAPHS

Photo No. <u> </u>	<u>Description</u>
1.	Aerial view of dam looking northeast.
2.	Aerial view of spillway area looking east.
3.	Upstream face of dam looking west from right abutment; note erosion and minor sloughs.
4.	Crest of dam looking southwest from right abutment; note spillway bridge in foreground.
5.	Downstream face of dam looking east from left abutment.
6.	Erosion gully at left downstream dam-abutment contact.
7.	Marsh vegetation at left downstream dam-abutment contact near toe of dam.
8.	Wet areas (note marsh vegetation) in downstream floodplain beyond toe of dam.
9.	Spillway crest area with bridge over spillway looking downstream.
10.	Left support of spillway bridge (concrete wall) looking downstream.
11.	Right support of spillway bridge (bedrock) looking downstream.
12.	Approach area to spillway looking upstream from bridge.
13.	Spillway outlet area looking downstream from bridge.
14.	Siphon system (downstream end); note flexible corrugated discharge pipe.
15.	Downstream area looking from crest of dam.
16.	Lake area looking from crest of dam.



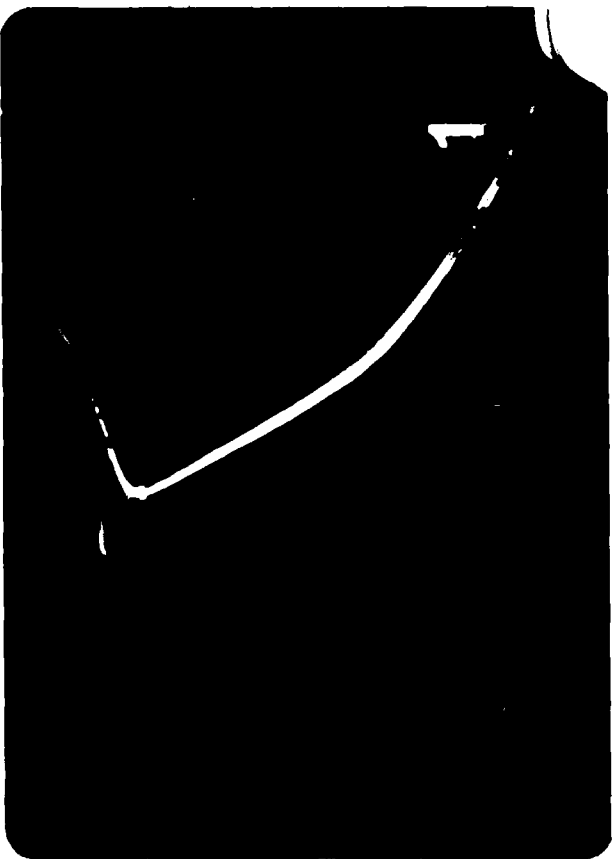
PHOTOGRAPH LOCATIONS

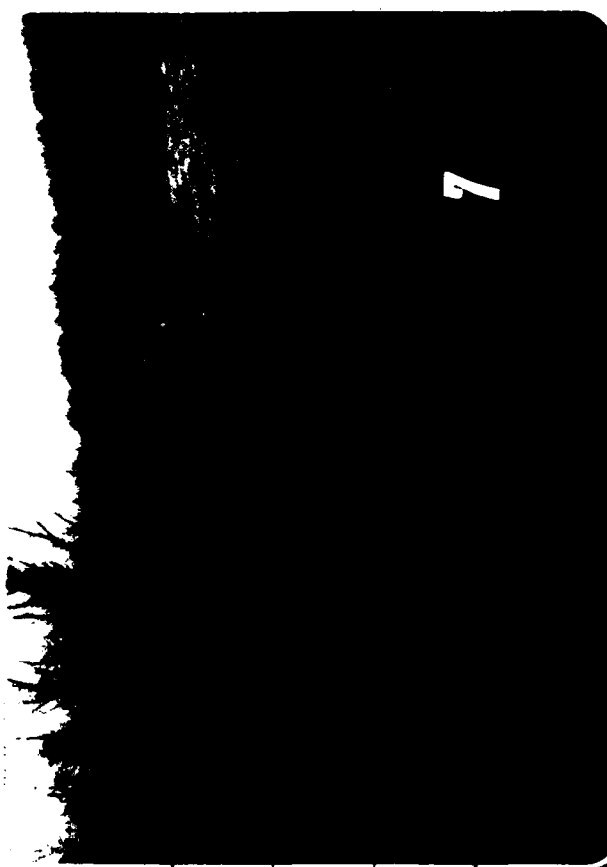
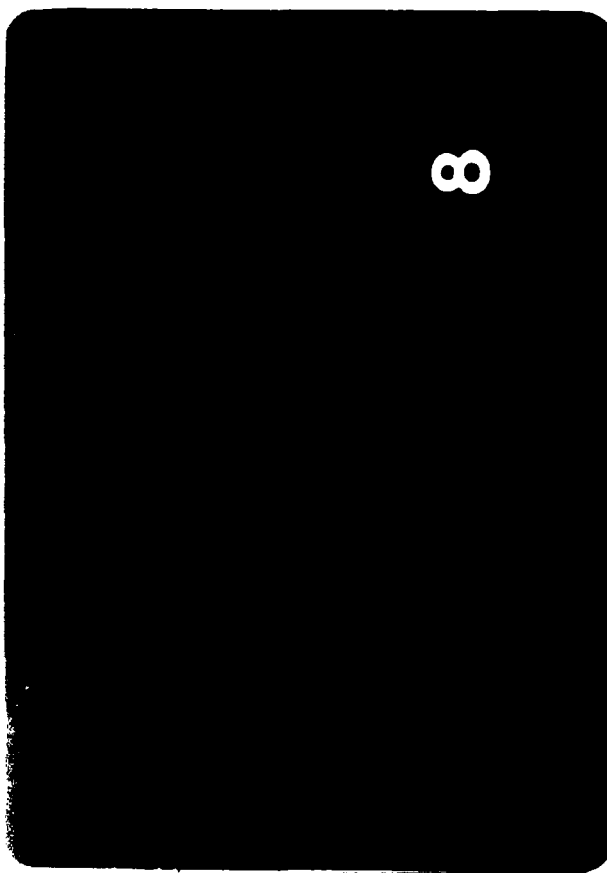
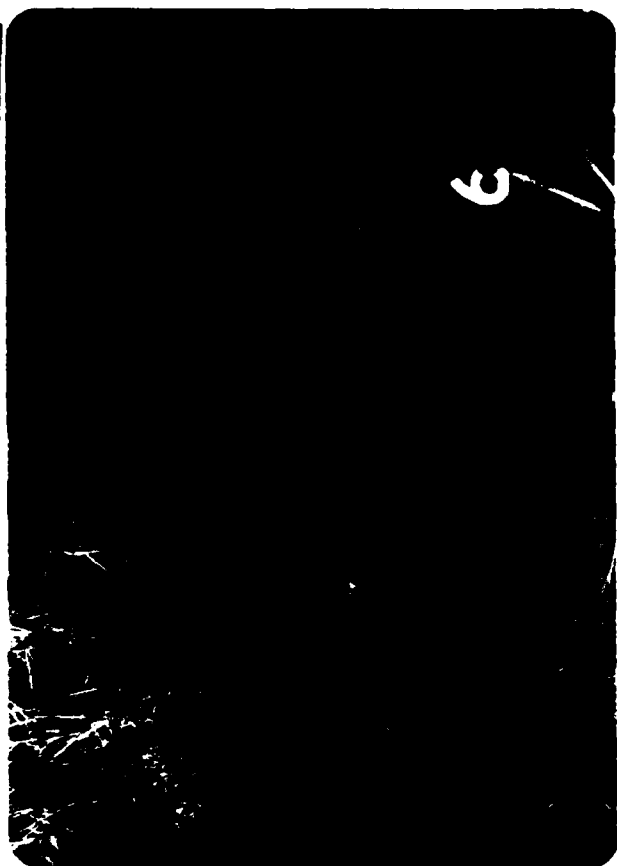


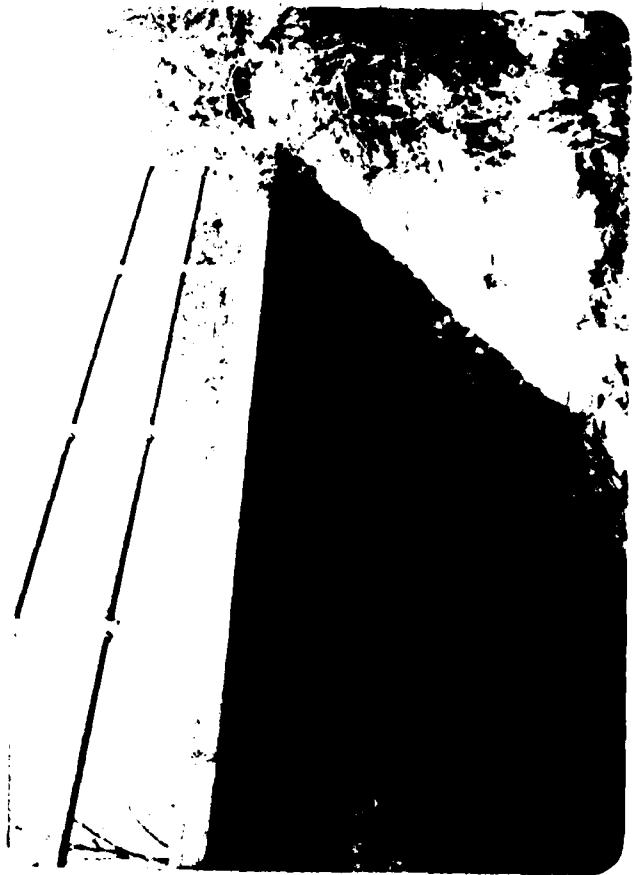
SPRINGFIELD, IL • PEORIA, IL • ROCKFORD, IL

Lake Kah - Tan - Da Dam
Perry County, Missouri
Mo. I.D. No. 30838

Sheet 2, Appendix D

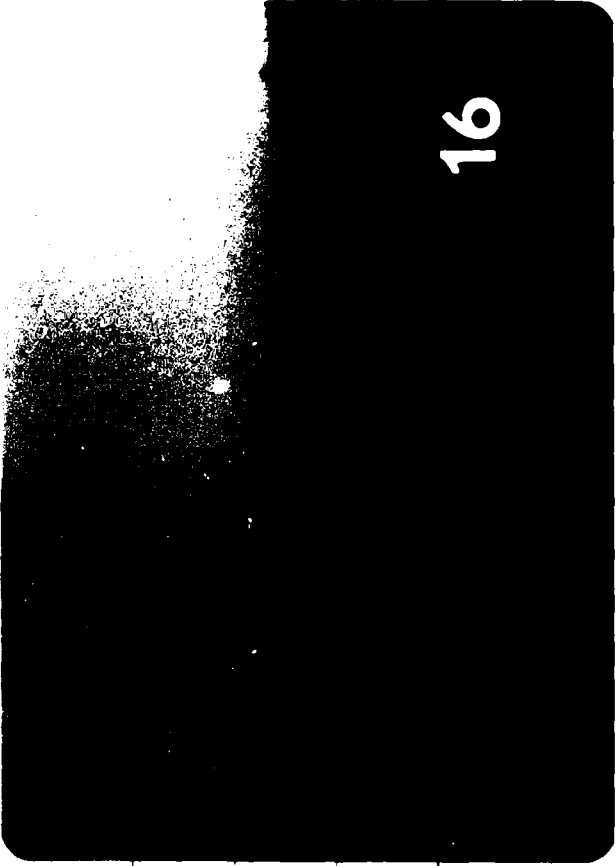




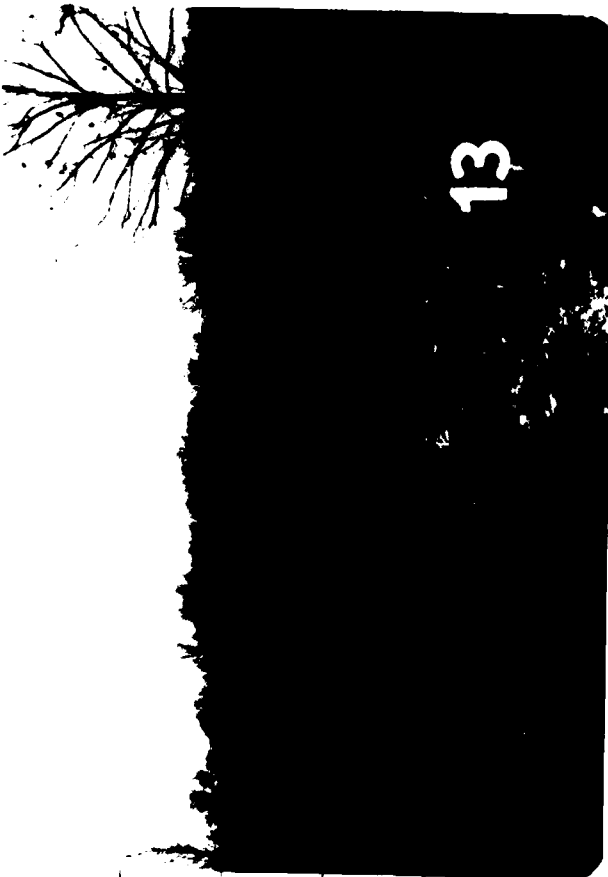




14



16



13



15

